From Volatility to Value:

Analysing and Managing Financial and Performance Risk in Energy Savings Projects

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Abstract

Many energy investments are made without a clear financial understanding of their values, risks, and volatilities. In the face of this uncertainty the investor—commonly an energy service company—will often choose to implement only the most certain, often shallow, energy-efficiency measures. Conversely, commodities traders and other sophisticated investors accustomed to evaluating investments on a value, risk, and volatility basis often overlook energy-efficiency investments because risk and volatility information are not provided. Fortunately, energy-efficiency investments easily lend themselves to such analysis using tools similar to those applied to supply-side risk management. We propose applying the techniques of financial risk management analysis to energy-efficiency investing. Accurate and robust analysis tools demand a high level of understanding of the physical aspects of energy-efficiency, to enable the translation of physical performance data into the language of investment. With a risk management analysis framework in place, the two groups, energy efficiency experts and investment decision-makers, can exchange the information they need to expand investment in demand-side energy projects. In the first part of this article, we present the case for and the elements of risk analysis in energy efficiency. In the closing sections we describe risk management strategies and the business opportunities they afford.

Keywords: Energy Efficiency, Risk Management, Finance

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Towards A Unified Risk Management View of Energy Efficiency

The enormous potential for energy savings is well established, as is the fact that the goal has proven elusive (Moomaw et al. 2001). While historical efforts have been considerable, progress has slowed due in part to a lack of "fit" with established financial decision-making and risk-assessment frameworks. Energy managers and investment decision-makers simply do not speak the same language. As an indication of the disconnect, over the past 15 years the so-called "Energy Services" industry has managed to implement only a small fraction of the available energy-efficiency investments in buildings and industry, even in North America where it is relatively well established. Many high-yield investments remain, yet growth in that industry is slowing (Goldman et al. 2002).

The situation traces in part from the fact that energy management is considered primarily a physical necessity (or luxury), not a financial opportunity. While highly skilled at designing physical systems, energy engineers are often frustrated to see their proposed energy productivity improvements go overlooked by CFOs and investment analysts. By working together to develop a methodology and language to value energy projects alongside other investments, both parties (energy managers and investment decision-makers) can ensure that the gap is closed.

Energy efficiency experts, as scientists and engineers, tend to avoid measures that show evidence of uncertainty. To them, risk management means finding engineering solutions that eliminate risk. They see the uncertainties of energy savings projects strictly as liabilities. Rather than attempt to quantify these uncertainties, thereby enabling risk management, energy performance contractors favor stipulating the potential energy savings. The stipulated savings are often discounted to reflect the potential downsides, with no credit for potential upside. Finance traders and traditional investment analysts, however, see risk management as a set of tools for comparing investments on the basis of value, risk, and volatility. One example of this is Enterprise Risk Management as defined by the Casualty Actuarial Society in 2001*: The discipline by which organizations assess, control, exploit, finance and monitor risk from all sources for the purpose of increasing the organization's short- and long-term value to its stakeholders*. In this framework, risk is not simply a potential liability; it is also a potential opportunity.

The attitude that uncertainty should be avoided rather then quantified, limits and shrinks opportunities for energy-efficiency measures. In the United States, many energy performance contractors have been unwilling to provide 100% savings guarantees because of concerns about future volatilities that could adversely affect their savings predictions.[1] In addition, their customers rarely understand the associated uncertainties and are thus unequipped to value the premium requested for guaranteeing energy savings.

Specific factors adversely affecting the establishment of guaranteed savings include:

- Inadequate time or methodology to establish an accurate volumetric consumption baseline.
- Inability to monitor behavioral changes that could result in greater consumption of energy when new equipment is installed.
- Inability to monitor actions that could decrease asset efficiency, such as poor maintenance.
- Volatility in future energy rates, currency exchange rates, interest rates, etc.

When estimates of energy savings potential are lowered, the anticipated internal rate of return of some energy savings projects can be reduced to the point that their investment potential is no longer attractive to the end-user or policymaker. Such projects might devolve into simple equipment leases. Performance verification—an important source of value, risk, and volatility data—is subsequently removed from energy plans. Meanwhile, perceived risk forces lenders to increase the cost of borrowing, which in turn erodes the intrinsic cost-effectiveness of energy efficiency projects and lowers the overall level of available financial resources.

To shift to a more sophisticated, financially astute risk management paradigm, the performance contracting industry, in collaboration with the public sector or other neutral and credible entities, must build a risk framework to address:

- Project Intrinsic Volatilities—those energy consumption elements directly affected by changes *within* the facility, and are thus measurable, verifiable, and *controllable*. This includes the energy volume risk, asset performance risk, and energy baseline uncertainty risk.

[1] Of fifteen companies providing information in the Goldman et al (2002) study, seven guaranty 100 percent of the savings, six guaranty 50 to 100 percent, and two guaranty less than 50 percent.

- Project Extrinsic Volatilities—those energy consumption risks which are *outside* the facility, and *hedge-able*. These include energy price risk, labor cost risk, interest rate risk, and currency risk (for cross-border projects).

As the data within this framework becomes robust, it will evolve into the equivalent of the insurance industry's actuarial tables, for the considered measures against specific conditions that materially impact savings.

Reaching this final stage requires industry standardization and public and private efforts to identify and compile data on both the aforementioned intrinsic and extrinsic volatilities and on energy audits, measurement, and verification.

When values, risks and volatilities of efficiency measures are understood, they can be evaluated alongside other financial investment options and thereby have a greater chance of acceptance by a wider audience.

This article offers a means of unifying the "physical" and the "financial" by presenting a practical language for bridging the two worlds (Table 1).[2] We argue that the risks associated with energy efficiency investments can not only be managed, but can be turned into opportunities. We outline the business logic and a conceptual framework for quantifying and managing these risks, and present business models and public-private initiatives for capturing the considerable untapped value. This perspective is also relevant to managing risks in the emerging markets for tradable green certificates, carbon emissions trading, and the like (Huld *et al*. 2003)

A Supply Side Example: Managing Volatility

During what in retrospect seem like simpler times, the revolution of on-line trading in the wholesale power markets allowed market participants to effectively manage their exposure to energy commodity price volatility. While originally considered unworkable, the commoditization of energy supply quickly grew to become a multi-billion-dollar business. Energy transactions could, it was thought, find their place in the world of structured finance in which investments and projected cash flows are bundled and sold in large packages like other financial derivatives. New terms of art emerged, such as: weather derivatives, emissions trading, viewing saved energy as "negawatts", and physical hedges.

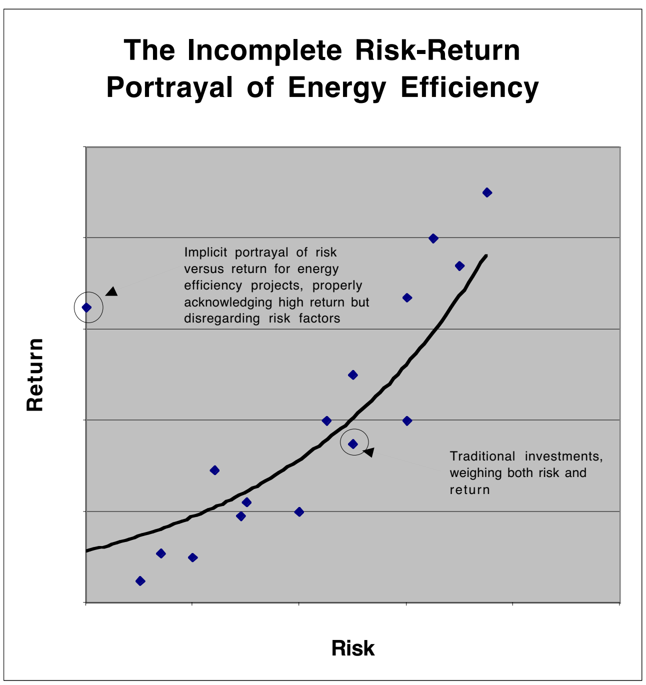


Figure 1. Risk-Return *The "risk-return" view applied to most investments is rarely considered when valuing potential energy-efficiency investments*

Recent chaos in the Western US power market, the collapse of Enron, and solvency crises among some of the nation's largest energy utilities have brought increased attention to risk management and accounting practices in the energy sector, and have highlighted the vulnerability of the larger economy to volatility in the energy arena. The roots of this volatility are both financial and physical. For example, rough estimates place the costs of electric power disruptions as high as $100 billion per year. Whatever the exact value, the costs are clearly significant (Eto *et al.* 2001).

While seemingly well insulated from such head-spinning concerns, energy-efficiency projects have also become the object of scrutiny and scepticism, and the efficiency community is largely unprepared to cope with this. While energy savings estimates are often heroic, the risks are typically relegated to footnotes, at best (Figure 1). The absence of information on risk-return makes it virtually impossible for most investors to seriously consider energy efficiency.

[2] As discussed elsewhere, energy-efficient technologies also have physical risk dimensions of relevance to property loss, liability, business interruption, and life/health. This is yet another area of risk analysis that has received minimal attention by the energy management and policy communities (Mills 1996; Vine *et al.* 1999; Mills 2003a).

Diverse Audiences with a Common Need

There are four distinct constituencies for this new perspective. The first audience includes the financial services sector, including lenders, financial risk managers, and insurance companies. Their involvement in the energy services marketplace is very limited at present. The long-discussed but as yet unrealized prospect for the "securitization" of energy efficiency investments (Kats et al. 1996)—i.e. bundling many individual projects and their projected future cash-flows into portfolios that can be sold and traded in the financial marketplace as securities—clearly requires new methods of evaluating and managing the associated risks. Similarly, risk assessment and management methods are needed to provide the confidence necessary for the proper functioning of carbon emissions trading systems. Far more exotic things than energy efficiency have been securitized, including David Bowie's royalties and Italian tomato crops (Timmons 2002). Abuses of securitization, and the financial aftershocks have made it more challenging to apply this attractive strategy to energy efficiency, however.

The second audience includes in-house senior operations management as well as those in the energy services industry currently offering customer-oriented demand management products, but finding themselves with stagnant or diminishing markets on the one hand and increasing accounting scrutiny on the other. With increased interest in measurement and verification ("M&V"), and insufficient resources to "measure everything", there emerges a clear need to prioritize and rank the options. Clearly, some measures merit measurement more so than others, depending on the actual uncertainties and the level of risk acceptable to the customer.

The third audience is far broader, including virtually any owner/operator of energy-using facilities, especially those with a portfolio of holdings. This audience stands to benefit from the concepts presented here by helping them place prospective energy-efficiency investments on an equal footing with other investment opportunities.

The final audience includes a host of energy policymakers and policy advisers—from the local to the national and international levels—who are keenly aware that energy savings projects often under-perform and that the ultimately envisioned market penetration has remained an elusive goal. A leading example of advanced work in this arena is in the inclusion of uncertainty analysis in appliance standards work, discussed below.

Quantifying Risks: The History

It is no secret that energy savings estimates contain uncertainties and that many factors confound performance and produce volatility. Study after study has shown that energy savings often deviate significantly from predictions, and typically in unfavorable ways. In fact, sometimes savings don't materialize at all, and savings often fail to persist over time. Evidence for this dates back to the early 1990s (Heerwagen and Loveland 1991). This fact fosters the proverbial "cream-skimming" problem in which relatively certain (but relatively shallow) energy savings opportunities are selected in favor of more promising but more complex and uncertain measures. Emphasis on lighting efficiency projects is an often-cited example of this phenomenon. In a major review of historic experience in the US ESCO (Energy Services Company) market, 40% of projects had savings that deviated by more than 15% from projections and in 30% of the cases predicted savings were greater than actual (Goldman *et al.* 2002). The most commonly targeted end use by ESCOs is lighting.

The issue is being brought into focus again by deliberations over how much to discount (deflate) energy savings estimates that underpin emissions-reductions projections associated with carbon trading projects. It is sobering to see that these deflation factors range as high as 50% (Vine *et al.* 2003).

On the other hand, efficiency has some inherent risk-management *benefits* (e.g. as a form of protection or "hedge" against price volatility) (Mills 2002a,b). These, too, are rarely acknowledged or otherwise weighted into the investment decision.

Sources of Risk, Uncertainty, & Volatility

We have identified ten "zones" in which energy-efficiency project risks may reside (Table 2). These include the categories of economic, contextual, technology, operation, and measurement & verification risk. Each of these in turn has both intrinsic (controllable) and extrinsic (uncontrollable) dimensions.

Table 2. Matrix of risks associated with energy-efficiency projects.

	INTRINSIC FACTORS	Risk Management	EXTRINSIC FACTORS	Risk Management
ECONOMIC			Fuel Costs	Hedges; fixed-price contracts
			Demand Charges	Hedges; fixed-price contracts
			Cost of capital	Risk-based rates
			Exchange Rates	Hedges
			Labor Costs	Fixed-price contracts; Inflation bonds (dirty hedges)
			Equipment Costs	Fixed-price contracts; Inflation bonds (dirty hedges)
CONTEXTUAL	Information on facility	Due diligence; surveys	Environment	Pre-project data analysis. Weather Hedges.
	Applicability/feasibility	Careful design	Energy Service Levels	Contractual exclusions/adjustments
TECHNOLOGY	Equipment Performance	Design, specification, measurement; ESI; stipulated savings	Equipment lifetime	Careful design; specification; contractual exclusions
	System Performance	Measurement		
	Equipment Sizing	Design		
OPERATIONAL	Degradation of savings	Monitoring and diagnostics	Persistence	End-user training and information; contractual exclusions; occupant incentives
	Baseline Adjustments	Contractual adjustments		
	Indoor Environmental Quality	Liability insurance.		
MEASUREMENT & VERIFICATION	Data Quality	Engineering review		
	Modeling Errors	Model validation		
	Energy/ Power (kWh, therms, etc.)	Adequate measurement plan and equipment		
	Metering precision/accuracy	Proper metering specification/procureme nt/testing		

Examples of economic risks include energy-cost volatility, tariff structures, tariff levels, or labor costs. Examples of contextual risks include the quality and completeness of information on the facility, environmental conditions (e.g. weather patterns, energy service levels, and changes in occupancy). Examples of technology risk include equipment performance and lifetime. Examples of operational risks include degradation of energy savings over time due to poor maintenance or changes in baselines due to shifting operating hours, loads, etc. Risks related to the measurement and verification of savings range from simulation and metering accuracy to measurement bias.

Among the many sources of risk is mis-estimation of savings during design. Engineers must rely heavily on software tools that approximate the energy-use profile of buildings and calculate the savings from applying efficient technologies. These tools can yield widely different results even under highly controlled comparison conditions, for example –20% to +100% of the actual bill for the example shown in Figure 2.

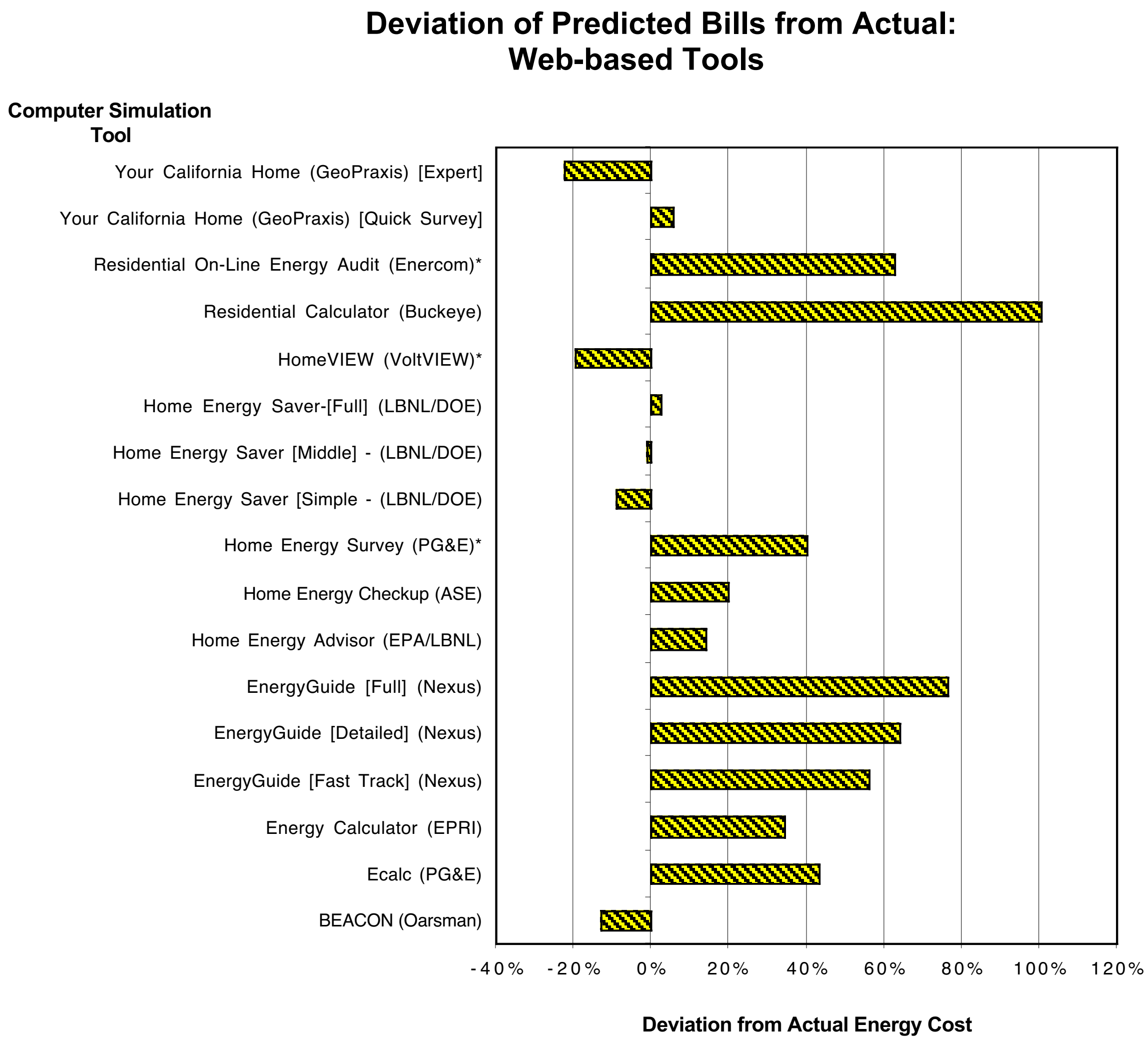


***Figure 2**. Deviation of predicted energy costs from actual for a collection of energy-analysis software tools. Example is for residential buildings, presumably more certain than predictions for non-residential buildings (Mills 2002a).*

The identification and allocation of risks to various parties is clearly an essential component of risk management. A simplified example is the "Risk/Responsibility Matrix" utilized by the US Federal Energy Management Program to help government project managers identify and assign risks of projects involving ESCOs (FEMP 2001).[3]

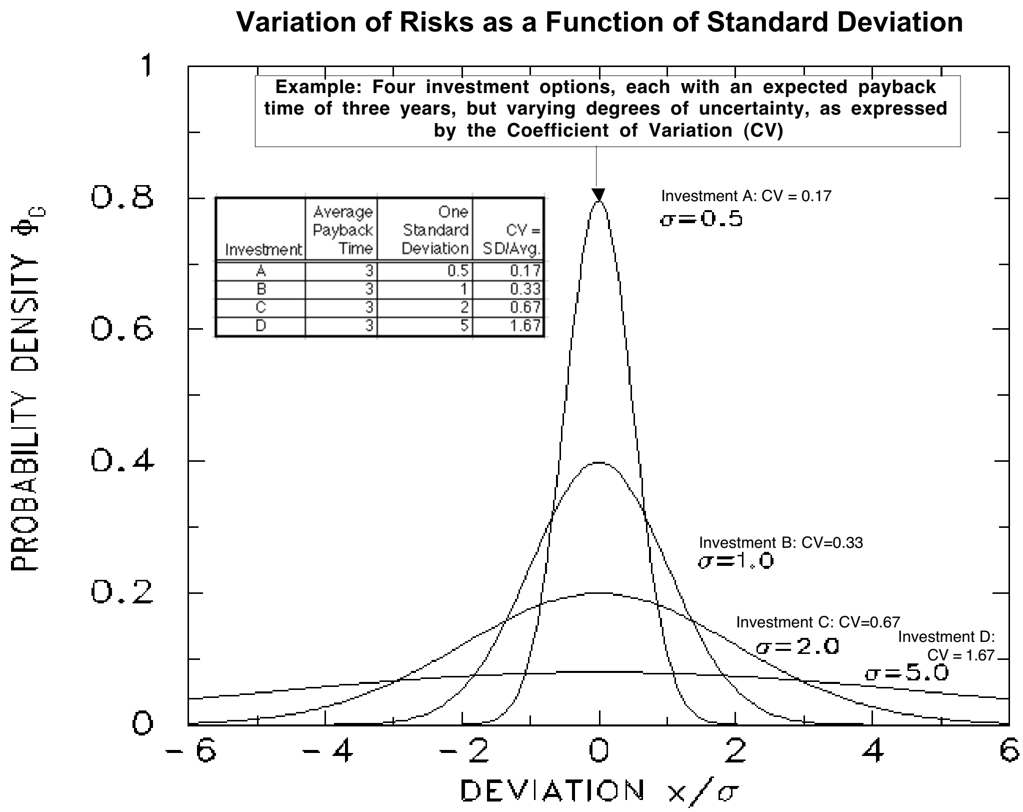
Analysis Methods

There are various ways to describe and analyze risk. . As discussed above, some risks are controllable (intrinsic), and others are not (extrinsic).

Rickard *et al.* (1998) provided an early treatment of this issue. A relatively simple and well-established statistical method for defining variability was applied to energy-efficiency projects, using the metric called "coefficient of variation, CV". The CV provides a way of comparing uncertainties for a variety of otherwise dissimilar physical processes or datasets. The normalization is accomplished by dividing the standard deviation of a distribution of possible outcomes by the average. Thus, efficiency measures (or other investment options) having different averages and/or

[3] See http://www.eren.doe.gov/femp/financing/espc/documents/risk_responsbility_matrix.doc

degrees of uncertainty can be meaningfully compared. With a smaller CV there is less the uncertainty and risk (Figure 3). Those evaluating and comparing investment options might plot the CVs for competing investment opportunities against the projected returns.



Investment	Average Payback Time	One Standard Deviation	CV = SD/Avg.
A	3	0.5	0.17
B	3	1	0.33
C	3	2	0.67
D	3	5	1.67

***Figure 3**. Use of the "Coefficient of Variation" to evaluate relative uncertainties*

Using this method, Rickard's study examined a number of ENERGY STAR buildings and plotted their CVs and returns against those of non-energy investment opportunities. Although the study made a number of significant simplifying assumptions, and excluded a number of risk factors, it provided a valuable visualization indicating that energy efficiency can be an attractive investment (Figure 4), although it also found a 7% chance of negative IRR.

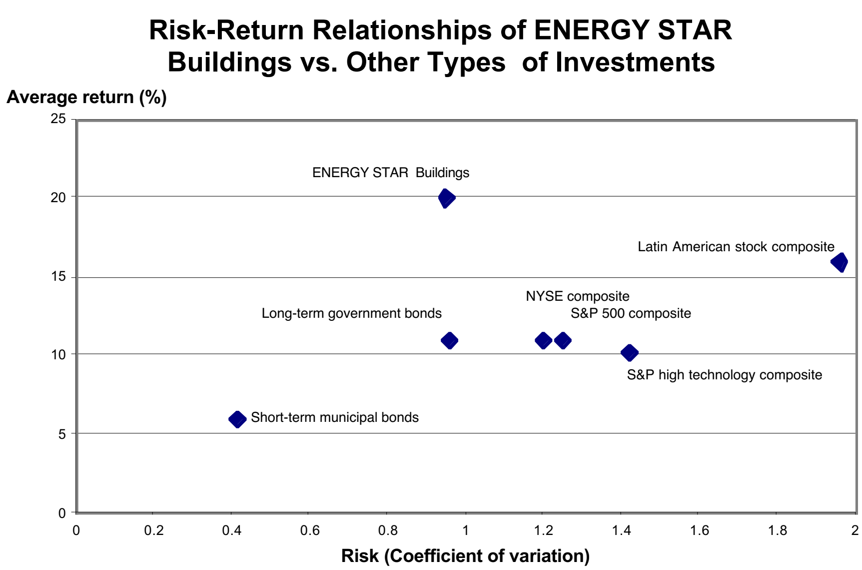


Figure 4. Estimate of the risk-return relationship for Energy Star buildings versus other types of investments.

In practice, an assessment of uncertainties has to examine and weigh a multiplicity of factors. In the public sector Lawrence Berkeley National Laboratory has developed a number of new methods for using uncertainty analysis to support policy decision-making. By using Monte Carlo analysis techniques, the uncertainties of multiple variables are being integrated into a unified economic assessment method (McMahon and Liu 2000; Lutz *et al.* 2000).[4] The probabilistic characteristics of each risk component were isolated to identify the appropriate risk management activities and priorities. As an illustration of the inputs to such analyses, Figure 5 shows a frequency distribution of lighting usage hours. Note that the risks of lighting operation are naturally bounded at zero hours and 8760 hours per year. Ballast purchase price (Figure 6) was similarly isolated and statistically evaluated. Here the upper bound of cost reflects historic pricing, not a physical absolute. The "importance analysis" flowing from these and other datasets actually ranks the impact of diverse variables on the ultimate financial performance (e.g. cost-effectiveness) of a particular energy efficiency strategy, as shown in Figure 7 for the case of electronic lighting ballasts.

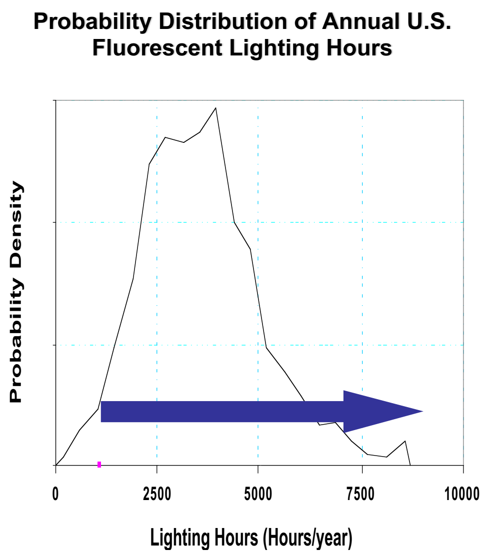


***Figure 5**. Probability distribution of annual fluorescent lighting hours. (Source: LBNL, Energy Efficiency Standards Group)*

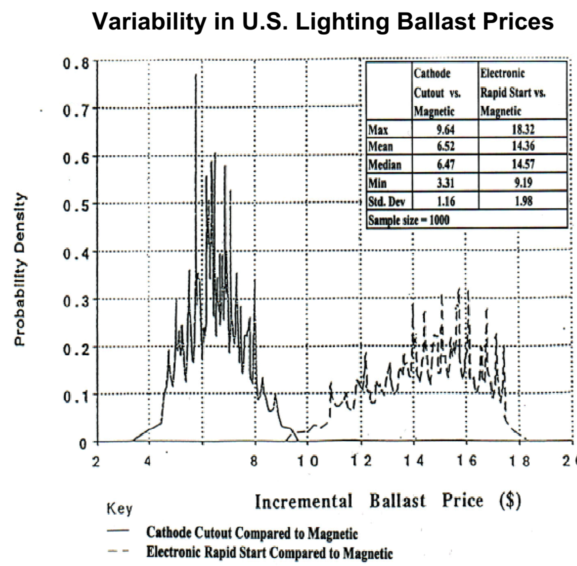


***Figure 6.** Variability in U.S. ballast prices (Source: LBNL, Energy Efficiency Standards Group)*

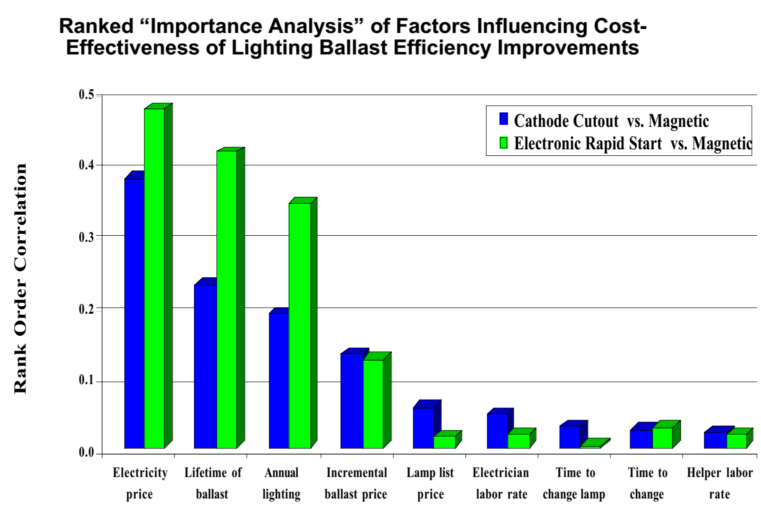


***Figure 7**. Ranked "importance analysis" of factors influencing cost effectiveness of ballast efficiency improvements. (Source: LBNL, Energy Efficiency Standards Group)*

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[4] For example, the LBNL residential electric water heater life-cycle cost model involves approximately 120 input distributions in five sequential analysis modules (McMahon and Liu 2000).

While the purpose of this particular analysis is to inform policymakers on issues such as equity impacts of equipment standards at a national scale, it is readily transferable to a project or portfolio scale. The analysis also shows that taking a probabilistic view reveals that for certain conditions a proposed investment may not be cost effective at all. Figure 8 shows an example of the distribution of possible life-cycle costs for electronic lighting ballasts.

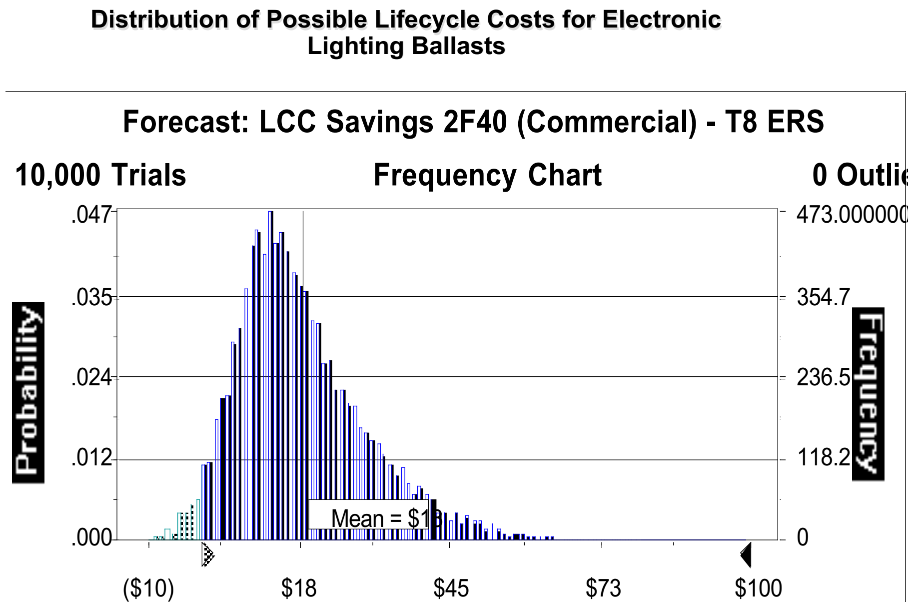


Figure 8. *Distribution of possible lifecycle costs for electronic ballasts. Variables included: lighting hours, ballast life, ballast price, electricity price, labor, and labor costs. (Source: LBNL, Energy Efficiency Standards Group)*

In the private sector the authors developed a similar framework for analyzing the risk in a $300M energy efficiency portfolio. Investments in client facilities were evaluated based on their expected values and the distribution of probably results: the "curve" (Mathew *et al*. 2003).

Risk assessment techniques must be tailored for the particular audience in question. Real estate investors—one key constituency—provide a case in point. This community utilizes particular indicators of financial performance (value) such as "net operating income" and "return on equity" (cash-on-cash return) (Harvard Business School 1995). For the real estate investor, showing the sensitivity of returns in the face of energy price volatility can be a powerful way of establishing the value of energy efficiency. Figure 9 illustrates that energy-efficiency not only improves the return on assets, but also provides a hedge against erosion of those returns in the face of energy price spikes. This results because the overall role of energy costs in the income/expense equation is lower if the property is energy efficient. The key factor here, is that the figure of merit is not the performance of the energy-efficiency measure(s) in isolation, but their impact on broader areas of concern.

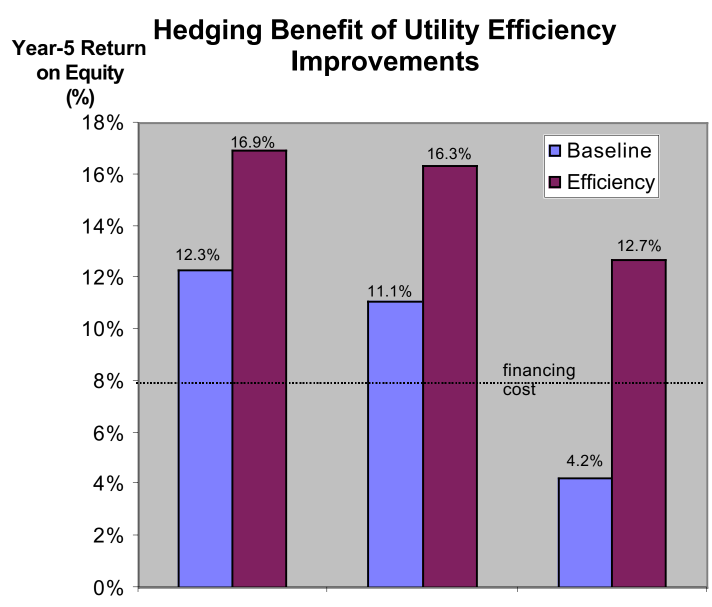


Figure 9. *Reducing energy demand lowers the dependency of profits on energy bills (Mills 2002b)*

Risk Management

Fortunately, there are a variety of techniques for managing the risks outlined in Table 1. These range from technical approaches to quantifying and measuring savings to financial and contractual strategies that identify and explicitly allocate risks to various parties. Risk can also be managed and spread by assembling portfolios of projects, as opposed to single projects where there are no gains to offset a potential loss. As seen in Figure 10 a, weather-normalized energy savings from 24 public housing retrofit projects show a wide range of savings, and variability in savings over time. By viewing these projects from a portfolio perspective, however, the volatility is dampened considerably. In the case shown, a range of savings from –12% to +52% among individual projects is reduced to a range of +16 to +25% for the portfolio.

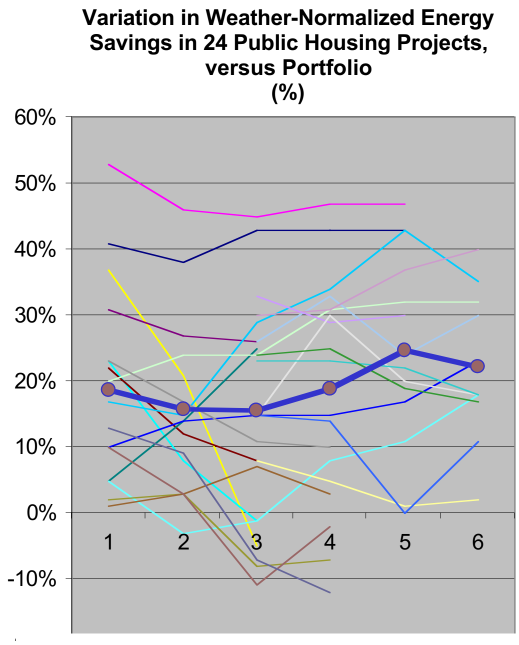


Figure 10. Aggregation of projects largely offsets volatility caused by uncertain persistence of savings. (Source: Data from Ritschard and McAllister, 1992).

Technical approaches to risk management range from building commissioning and other quality assurance measures, to specialized operations and maintenance programs, to measurement and verification programs based on the public domain guidelines, such as the International Performance Measurement and Verification Protocols (IPMVP 2001).[5]

A variety of financial instruments are available for managing risk. These include hedges and insurance products. Among the latter is energy savings insurance, in which an insurance contract is put in place to guaranty that payments are made in the event that energy savings are under-achieved (Mills 2003b). ESI is appreciated by project lenders and can result in lower financing costs. The contracts are often written such that claims are used to meet the debt service otherwise secured by the energy savings stream. Although a number of insurers offer ESI (Mills 2003b), the product is in its infancy. Unfortunately, ESI is at present a mix of art and science. While ESI providers use considerable engineering due diligence, they have yet to develop truly actuarial approaches to screening and "underwriting" potential projects, which has significantly limited the growth of this product line.

Actuarial pricing: An example of portfolio-based risk management

Enron's experience with actuarial pricing of energy efficiency projects is a significant example of the application portfolio-based risk management. While the merits of this strategy may have been masked by the larger failure of the company, it nonetheless illustrates the value and opportunity for risk management services in the energy efficiency business. The conventional approach to pricing energy-efficiency projects (via detailed site audits) took too long, and precluded a "low-touch, high-volume" sales process. In essence, Enron sought to price energy efficiency projects much like insurance policies—where a policy can be priced based on a few standard questions. Insurance companies rely on actuarial tables to develop a risk profile for a customer based on their characteristics. Similarly, Enron sought to price the overall value of energy savings projects in a customer portfolio using pertinent customer site characteristics, without doing detailed engineering audits on individual sites. In order to accomplish this, an actuarial database of energy-efficiency project data was developed, wherein project costs, savings, schedule data were stored in a standardized format to facilitate actuarial analysis (Mathew et al. 2003).

Figure 11 illustrates an energy conservation measure (ECM) savings curve developed from the actuarial database. This particular curve describes the annual electrical savings from using setback controls for roof-top packaged HVAC units in office buildings, expressed in annual kWh savings per ton of cooling capacity. The curve is further specific to a particular region (northeast US) and equipment age (more than 5 years). This curve is essentially a histogram of the savings from similar projects recorded in the database—including both predicted and measured savings. This curve can therefore be used to estimate the savings from prospective setback controls projects, with just two parameters – location

[5] See http://www.ipmvp.org

and equipment age – which can be obtained without site audits. While the uncertainty for a given site maybe high, the risks can be diversified across a portfolio of projects.

The actuarial pricing approach was most commonly used for lighting retrofits, upgrades to packaged HVAC unit replacements, and certain compressed-air system measures. In a few cases, pricing was done exclusively using an actuarial approach. In fact, plans were underway to develop standard products that could be sold with a “low-touch, high-volume” sales process. For example, a product for the hospitality industry would have bundled two guest room energy conservation measures—occupancy sensors and CFL replacements—and priced them exclusively from the savings curves, using a limited amount of easily obtained site data, such as number of rooms, location, and occupancy rates. As a portfolio risk management strategy, actuarial pricing is well suited for large portfolios of homogenous facilities such as retail outlets and hotels, where it has the potential to dramatically reduce transaction costs and increase the scale of energy services delivered.

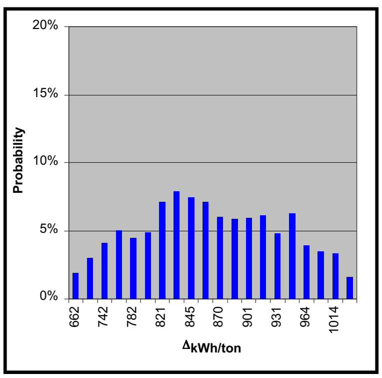
Executable Curve

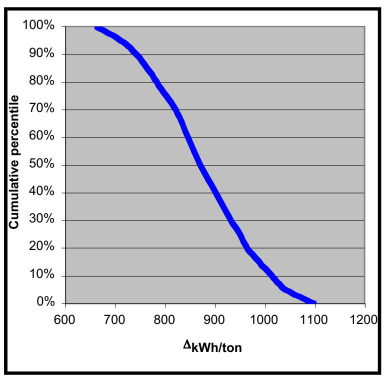
Not Valid for Pricing Without Signoffs

Facility Type:	**Office (c2)**	**Curve ID:**	**c2-321-DkWh-ton-1**
System:	**Packaged Units (3)**	**Release Date:**	
ECM Group:	**Controls (g32)**	**Valid Until:**	
ECM:	**Night Setback (321)**	**IAMF Signoff:**	
Metric:	**ΔkWh/ton (kWh saved/ton)**	**EAM Desk Signoff:**	
Customer:	**N/A**		

Key Drivers	Criteria
Location	Northeast
Unit Age	> 5 yrs

Curve Summary	
Mean	**875.27**
Std Dev	**100.16**
Score	**40**
Trans %ile	**15%**
Trans val.	**764.16**





Curve Percentiles	
%ile	value
0%	662.05
5%	711.50
10%	741.96
15%	764.16
20%	782.19
25%	802.46
30%	820.97
35%	833.77
40%	845.24
45%	857.41
50%	870.20
55%	885.28
60%	900.79
65%	916.12
70%	930.97
75%	949.85
80%	964.36
85%	987.57
90%	1,013.78
95%	1,041.09
100%	1,098.68

Release Notes:
1. This curve has a VAR limit, maintained by EAM desk

Figure 11: *Sample energy conservation measure (ECM) savings curve generated from actuarial database.*

Towards Greater Focus on the End User: Enabling Initiatives & Business Models

Teton Energy Partners has initiated a new proprietary business method that utilizes this framework (and assumes that Industry standardization will eventually take place): applying Real Option Theory in order to monetize the future volatilities surrounding energy savings projects for the benefit of the end-user. Energy Performance Contractors will compete for the exclusive right (hard option) to identify and install those energy projects that met the end-user’s threshold internal rate of return (IRR).

The value of this Option will increase or decrease, as follows:

- The larger the amount of the total installed cost, the more valuable the Option.
- The larger the allowable performance contractor's gross margin, the more valuable the Option.
- The longer the Option period, the more valuable the Option.
- The higher the minimum IRR threshold, the less valuable the Option.
- The fewer downside project extrinsic volatilities, thee more valuable the Option.
- The higher the project intrinsic upside volatilities, the more valuable the Option.

In summary, this Option will always have some value, unless the confidence level that the stipulated minimum IRR can be achieved diminishes to the point that it becomes worthless.

As previously stated, when more data becomes available for different types of end-users, it is very possible that an insurance-like actuarial table approach can be utilized to determine the above-referenced probability and variance determinations.

One can envision a time when the energy performance contracting industry potentially enters into a "virtuous cycle": Higher IRRs will be achieved, allowing a much greater number of projects to be implemented, leading to fungible energy projects, which can be monetized, in turn "priming the pump" for a greater number of projects to be installed, and so on.

Eventually, a logical next step will be the creation of an "Energy Performance Contracting Standards Board," ensuring that the highest professional standards are maintained, and further institutionalizing the energy savings performance contracting (ESPC) process. Similarly in the case of carbon emissions trading, analysts have suggested the need for international consensus rules on how to value and credit investments in emissions reductions (Vine *et al.* 2003).

There is also a timely coincidence of need for risk management, and risk managers looking for new services to offer to upper management (Richter Quinn 2002). In the wake of the corporate accounting crisis, firms are scrambling to develop more sophistication in accounting and risk management. Energy accounting will thus be expected to involve more rigour than has been the case in the past. The future energy manager will have a far broader scope than at present, and will increasingly be looked on to work with risk managers in addressing financial volatility associated with energy savings and energy asset management. They will find themselves less marginalized and a more integral part of corporate decision-making.

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